# Biological Agents

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## Lesson Administrative Page

**Module:** Biological Agents

**Scope:** This module provides individuals with an understanding of biological agents. The module addresses the types of biological agents, general signs and symptoms to recognize exposure, and the physical characteristics of biological agents.

**Instruction Objective(s):**

**Terminal Learning Objective:** At the conclusion of this module, the student will describe biological agents, the signs and symptoms of exposure, and any physical characteristics of biological agents.

Enabling Learning Objective 1.1: Describe biological agents

Enabling Learning Objective 1.2: Describe the general signs and symptoms of exposure to biological agents

Enabling Learning Objective 1.3: Describe the physical characteristics of biological agents

**Practical Exercise:** None

**References:**


- National Center for Biomedical Research and Training Academy for Counter Terrorist Education Louisiana State University and Agricultural and Mechanical College. *WMD Awareness for the Healthcare Professional*. Baton Rouge, LA: Louisiana State UP, 2003.
- Chin, James, MD, MPH, ed. *Official Report of the American Public Health Association Control of Communicable Diseases Manual.* 17th ed. New York: The Association, 2000.
- Sidell, Frederick R., *et al*. *Jane's NBC Chem-Bio Handbook*. 2nd ed. Surrey, UK: Jane's Information Group, 2002.
- "Tularemia as a Biological Weapon." *Journal of the American Medical Association*. Vol 285 David T. Dennis et al. 20 Aug. 2004. ‹http://jama.amaassn.org/cgi/content/full/285/21/2763›.
- *Field Management of Biological Casualties Handbook*. Life Safety Systems. Aug. 2004. ‹http://www.lifesafetysys.com/osb/itemdetails.cfm/ID/457›.
- U.S. Department of Transportation. *2000 Emergency Response Guidebook.* Chicago: LabelMaster, 2000.
- U.S. Centers for Disease Control and Prevention. ‹http://www.cdc.gov›.

**Duration:** 1.0 hours (When this course is taught as Train the Trainer, the duration is extended to 2.0 hours in order to provide time to discuss teaching points thoroughly.)

**Method of Instruction:** Facilitated seminar format in a classroom environment

**Instructor Ratio:** 1:50 Students

**Required Reading Assignments:** None

**Evaluation Strategy:** End of course discussion

## Biological Agents

Describe biological agents

Describe the signs and symptoms of exposure to biological agents

Describe the physical characteristics of biological agents

Homeland Security

## RAIN

**R**ecognize characteristics of biological agents

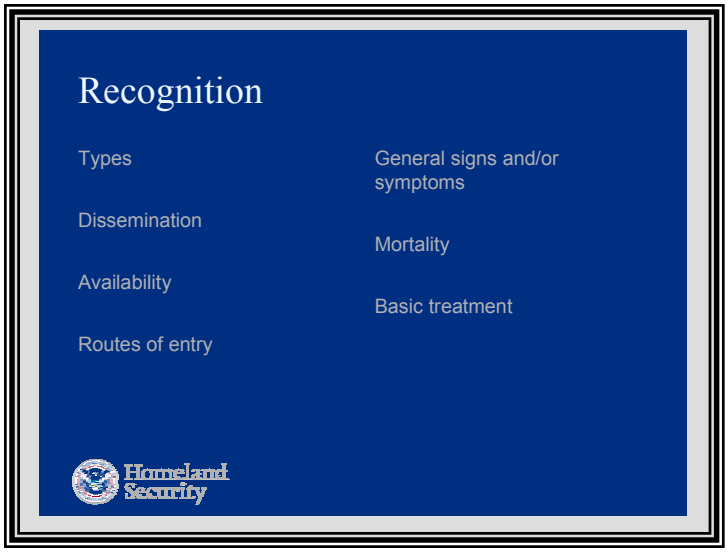
**A**void, by protection, the hazards of biological agents

**I**solate the hazards of biological agents

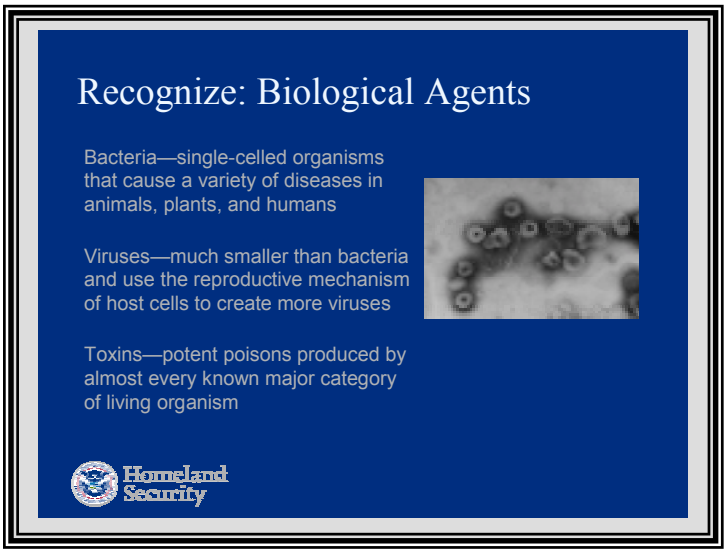
**N**otify the appropriate resources and authorities when responding to a WMD event possibly involving biological agents


Homeland Security

## Recognize: Biological Agents as WMD




- Types—Examples of biological agents—including the biological classification
- Dissemination—How the agent is dispersed. This is an especially important consideration for the awareness individual to assist in recognition information, how to evacuate, how to identify agents, etc
- Availability—If the agent is commercially available to acquire, or if it is found in a natural setting




- Routes of entry—Biological agents have several routes of entry into the body: inhalation, ingestion, absorption, or injection; gases or aerosols can be breathed in, residue that has settled on food or drink products can be eaten
- General signs and/or symptoms—A sign indicating the presence of a disease; a symptom is a change from normal function, sensation, or appearance, generally indicating disease or disorder
- Mortality—Potential for death resulting from a biological event
- Basic treatment—General medical attention given to expected victims on discovery of possible exposure to biological events

Biological weapons take the form of disease-causing organisms or toxins produced by living organisms. They can be categorized into three groups:

- *Bacteria*—single-celled organisms that cause a variety of diseases in animals, plants, and humans; they may also produce extremely potent toxins inside the human body
- *Viruses*—much smaller than bacteria and use the reproductive mechanism of host cells to create more viruses
- *Toxins*—potent poisons produced by almost every known major category of living organism; fungi, flowering plants, and bacteria produce many of the most deadly toxins

## Bacteria

### Anthrax (ăn-thrăks)

- Type—Bacteria—Anthrax
- Dissemination—Solid
- Availability—Naturally occurring; widespread usage in labs throughout the U.S.
- Routes of entry—Inhalation, ingestion, absorption, or injection. Humans can become infected with anthrax by handling products from infected animals, or by breathing in anthrax spores from infected animal products like wool, for example). People also can become infected with gastrointestinal anthrax by eating undercooked meat from infected animals. Not transmittable through human contact with the exception of cutaneous anthrax, which is similar to a blood borne pathogen


- General signs and/or symptoms—The early symptoms are flu-like—chills, fever, nausea, and swelling of lymph nodes

- Mortality—Early treatment of cutaneous anthrax is usually curative, and early treatment of all forms is important for recovery. Patients with cutaneous anthrax have reported case fatality rates of 20% without antibiotic treatment and less than 1% with it. Although case-fatality estimates for inhalational anthrax are based on incomplete information, the rate is extremely high, approximately 75%, even with all possible supportive care including appropriate antibiotics. Estimates of the impact of the delay in post-exposure prophylaxis or treatment on survival are not known. For gastrointestinal anthrax, the case-fatality rate is estimated to be 25%-60% and the effect of early antibiotic treatment on that case-fatality rate is not defined

- Basic treatment—Three types of antiobiotics are approved for anthrax: ciprofloxacin, tetracyclines (tĕt-rə-**si**-klēn) (including doxycycline (dŏc-sə-**sī**-klēn), and penicillins). For people who have been exposed to anthrax but do not have symptoms, 60 days of one of these antibiotics is given to reduce the risk or progression of disease due to inhaled anthrax

**Case Study:**

In October 2001, two letters contaminated with *Bacillus anthracis* spores were processed by mechanical and manual methods at the U.S. Postal Service (USPS) Brentwood Mail Processing and Distribution Center in the District of Columbia. Four postal workers at the Brentwood facility became ill with what was eventually diagnosed as inhalational anthrax; two died. The facility was closed, and post-exposure prophylaxis was recommended for approximately 2,500 workers and business visitors. The investigation disclosed that both letters contained the same strain of anthrax, which was isolated and sent to the Army's bio-defense lab at Fort Detrick, Maryland. From there, samples were sent to a number of laboratories in the U.S. All the letters were postmarked in Trenton, New Jersey.

A photo editor at American Media in Boca Raton, Florida, also died as a result of exposure to anthrax.

A total of five people were killed by anthrax in 2001.

## Plague (plāg)


- Type—Bacteria—Plague—bubonic (byoo-**bŏn**-ĭk) and pneumonic (nyoo-**mŏn**-ĭk)
- Dissemination—Aerosol
- Availability—Naturally occurring; widespread usage in labs throughout the U.S.
- Routes of entry—Inhalation, ingestion, or injection; transmissible to man through the respiratory tract, causing pneumonic plague


Bubonic plague is not transmissible through human contact. Pneumonic Plague is transmissible through human contact

- General signs and/or symptoms—Pneumonic plague incubates in two to three days. High fever, chills, headache, hemoptysis (hĭm-**ŏp**-tĭ-sĭs), and toxemia, progressing rapidly to dyspnea (dĭsp-**ne**-ə), stridor (**strī**-dər), and cyanosis (sī-ə-**nō**-sĭs). Death occurs from respiratory failure, circulatory collapse, and a bleeding diathesis (dī-**ă**-thə-sĭs). Bubonic plague incubates in two to 10 days. Malaise, high fever, and tender lymph nodes; may progress spontaneously to the septicemic (sĕp-tĭ-**sē**-mĭc) form and spread to the lungs
- Mortality—Without early treatment, patients may die. About 14% (1 in 7) of all plague cases in the United States are fatal
- Basic treatment—Early treatment of pneumonic plague is essential. To reduce the chance of death, antibiotics must be given within 24 hours of first symptoms. Streptomycin is the antibiotic of choice. Gentamicin (jĕn-tə-**mī**-sĭn), the tetracyclines (tĕt-rə-**sī**-klēn), and chloramphenicol (klôr-ăm-**fĕn**-ĭ-kōl) are all effective against pneumonic plague. Antibiotic treatment for seven days will protect people who have had direct, close contact with infected patients

**Tularemia (tū-lə-rē-mē-ə)**


- Type—Bacteria – Tularemia
- Dissemination—Solid or aerosol
- Availability— Naturally occurring; widespread usage in labs throughout the U.S.
- Routes of entry—Inhalation, absorption, ingestion, or injection; not transmissible through human contact. People can get tularemia by being bitten by an infected tick, deerfly or other insect, handling infected animal carcasses, eating or drinking contaminated food/water, or breathing in the bacteria, *F. tularensis (tū-lă-**rĕn**-sĭs)*

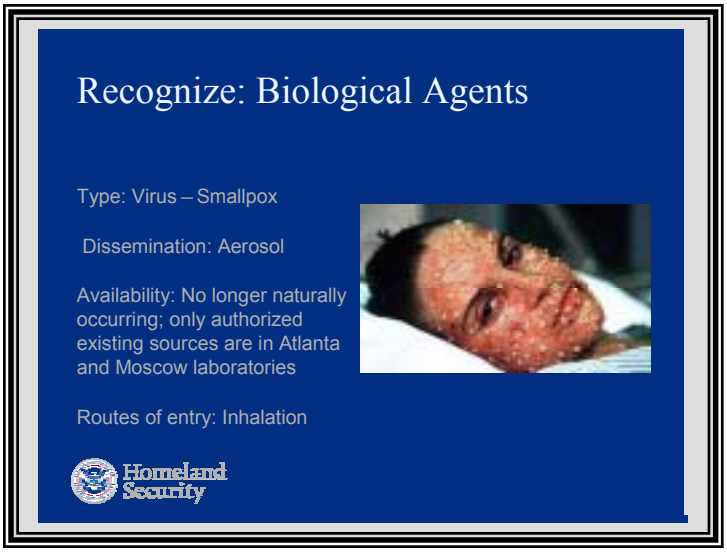

- General signs and/or symptoms—Sudden fever, chills, headaches, muscle aches, joint pain, dry cough, progressive weakness, and pneumonia. Symptoms usually appear three to five days after exposure to the bacteria, but can take as long as 14 days
- Mortality—Because the worldwide incidence of tularemia is not known, and the disease is probably greatly underrecognized and underreported. Reported cases in the U.S. have dropped sharply from several thousand per year prior to 1950, to less than 200 per year in the 1990s. Between 1985 and 1992, 1409 cases and 20 deaths were reported in the U.S., a case fatality rate of 1.4%. Currently, fatality rates are low, about two percent. Before antibiotic therapy was available, the fatality rate was about 7%. However, with early detection and treatment, death rates are greatly reduced

- Basic treatment—Early antibiotic treatment is recommended whenever it is likely a person was exposed to tularemia or has been diagnosed as being infected with tularemia. Several types of antibiotics have been effective in treating tularemia infections. The tetracycline class (such as doxycycline) or fluoroquinolone (flōr-ə-**kwĭn**-ə-lōn) ( class (such as ciprofloxacin (sĭ-prō-**flăk**-sin)) of antibiotics are taken orally. Streptomycin (strĕp-tō-**mī**-sĭn) or gentamicin (jĕn-tə-**mī**-sĭn) are also effective against tularemia, and are given by injection into a muscle or vein

## Viruses

### Smallpox

- Type – Virus – Smallpox
- Dissemination—Aerosol, person-to-person, or object to person (most common transmission method is large droplet of nuclei, such as sneezing)
- Availability—No longer naturally occurring; only known authorized sources are laboratories in Atlanta and Moscow





- Routes of entry—Inhalation. The virus must pass from person to person in a continuing chain of infection and is spread by inhalation of air droplets or aerosols. Smallpox spreads most readily during the cool, dry winter months, but can be transmitted in any climate and in any part of the world

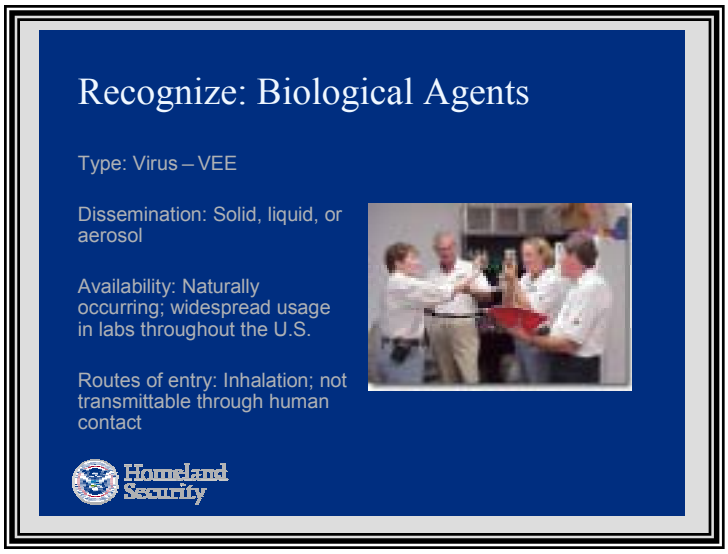
- General signs and/or symptoms—During the first two to three days of illness, smallpox causes symptoms that affect the whole body (systemic symptoms), including: high fever, often rising to more than 104 °F (40 °C), then dropping over two to three days; extreme lethargy, severe headache, severe backache, severe abdominal pain and vomiting (in some cases). The incubation period for smallpox is 12 days. However, symptoms can develop as soon as seven days or as long as 17 days after exposure. Smallpox may sometimes be confused with chicken pox, but differs in signs and symptoms. (Typically, chicken pox begins with a low fever, headache, rash, and a general feeling of sickness, or malaise. The rash starts as red bumps but quickly develops into small blisters that are extremely itchy. As the disease progresses, the blisters break open and form scabs, which fall off after about one to two weeks.) *Any outbreak of smallpox would be considered a major health threat and considered a terrorist incident*

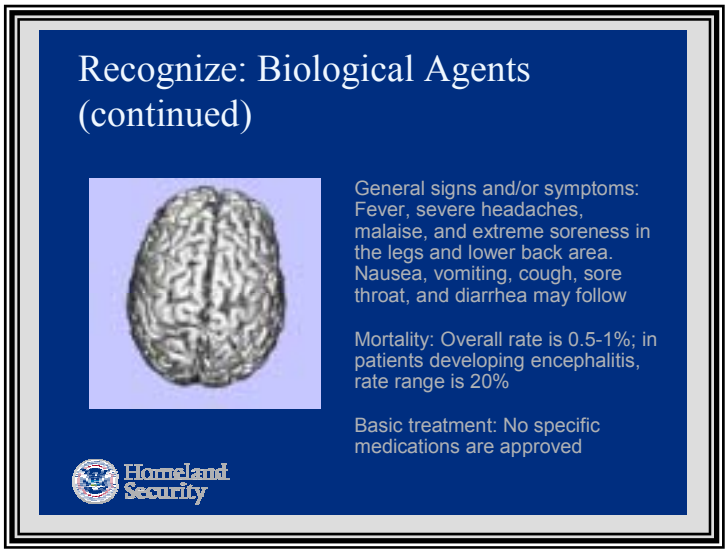
- Mortality—The majority of patients with smallpox recover, but death may occur in up to 30% of cases. Many smallpox survivors have permanent scars over large areas of their body, especially their face; Some are left blind

- Basic treatment—Smallpox can be prevented through use of the smallpox vaccine. There is no proven treatment for smallpox, but research to evaluate new antiviral agents is ongoing. Early results from laboratory studies suggest that the drug cidofovir (sī-**dō**-fə-vēr) may fight against the smallpox virus; currently, studies with animals are being done to better understand the drug's ability to treat smallpox disease (the use of cidofovir to treat smallpox or smallpox reactions should be evaluated and monitored by experts at NIH and CDC). Patients with smallpox can benefit from supportive therapy (e.g., intravenous fluids, medicine to control fever or pain) and antibiotics for any secondary bacterial infections that may occur

## Venezuelan Equine Encephalomyelitis (ĕn-sĕf-ə-lō-mī-ə-lī-tĭs) (VEE)

- Type—Virus
- Dissemination—Solid, liquid, or aerosol
- Availability—Naturally occurring; widespread usage in labs throughout the U.S.
- Routes of entry—Inhalation; not transmittable through human contact




- General signs and/or symptoms—Incubation period of one to five days; symptoms include fever, severe headaches, malaise, extreme soreness in the legs and lower back area; nausea, vomiting, cough, sore throat, and diarrhea may follow
- Mortality—The overall mortality rate from epidemics is 0.5-1%. In patients who develop encephalitis, the mortality rate is in the range of 20%
- Basic treatment—Treatment is symptomatic and, in a hospital emergency room, most likely involves correcting fluid deficiencies. No specific medications are approved for treatment of VEE. *In vitro* laboratory studies suggest that ribavirin (**rī**-bə-vī-rĭn) *n.* and other nucleoside analogues may be future agents, but they are not used clinically. Patients with possible VEE should be admitted to a hospital for observation for progression to encephalitis. In hospitals that do not have infectious disease specialists on staff, patients should be transferred to a tertiary referral medical center

## Viral Hemorrhagic Fevers (VHF)

- Type—Virus—VHF (Viral Hemorrhagic Fevers)
- Dissemination—Solid, liquid, or aerosol
- Availability—Naturally occurring; widespread usage in labs throughout the U.S.
- Routes of entry—Absorption, inhalation, ingestion, or injection



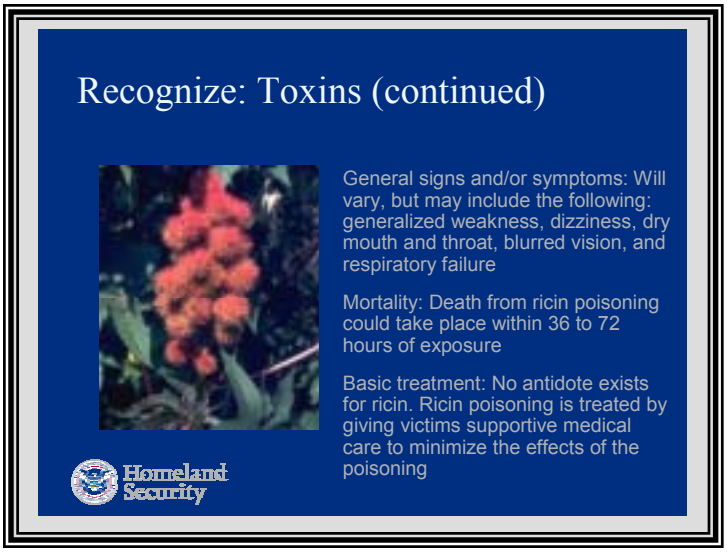
- General signs and/or symptoms—Specific signs and symptoms vary by the type of VHF, but initial signs and symptoms often include marked fever, fatigue, dizziness, muscle aches, loss of strength, and exhaustion. Patients with severe cases of VHF often show signs of bleeding under the skin, in internal organs, or from body orifices like the mouth, eyes, or ears. However, although they may bleed from many sites around the body, patients rarely die because of blood loss. Severely ill patient cases may also show shock, nervous system malfunction, coma, delirium, and seizures. Some types of VHF are associated with renal (kidney) failure

- Mortality—Case fatality rates of patients with VHF vary from less than 10% to approximately 90%, depending on the type of VHF. An outbreak of Ebola-Sudan in Uganda had a 50% case fatality rate. Complications from VHF infection include retinitis, orchitis, hepatitis, transverse myelitis, and uveitis. In patients who recover from Lassa fever infection, deafness is the most common complication. Spontaneous abortion also is common. Renal insufficiency is associated with Hemorrhagic Fever with Renal Syndrome (HFRS) infection

- Basic treatment—With a few noteworthy exceptions, there is no cure or established drug treatment for VHFs. Patients receive supportive therapy, but generally speaking, there is no other treatment or established cure for VHFs. Ribavirin, an anti-viral drug, has been effective in treating some individuals with Lassa fever or Hemorrhagic Fever With Renal Syndrome (HFRS). Treatment with convalescent-phase plasma has been used with success in some patients with Argentine hemorrhagic fever

**Toxins (tŏx-ĭns)**


- Type—Toxin
- Dissemination—Solid, liquid, or aerosol
- Availability—Commercially available; naturally occurring (example: ricin)
- Routes of entry—Inhalation, ingestion, or injection
- General signs and/or symptoms—Will vary, but may include the following: generalized weakness, dizziness, dry mouth and throat, blurred vision, and respiratory failure; onset of symptoms is one to 12 hours. Low blood pressure and respiratory failure may occur, leading to death




- Mortality—Death from ricin poisoning could take place within 36 to 72 hours of exposure, depending on the route of exposure (inhalation, ingestion, or injection) and the dose received. If death has not occurred in three to five days, the victim usually recovers

- Basic treatment—No antidote exists for ricin. Ricin poisoning is treated by giving victims supportive medical care to minimize the effects of the poisoning. The types of supportive medical care would depend on several factors, such as the route by which victims were poisoned (that is, whether poisoning was by inhalation, ingestion, or skin or eye exposure). Care could include such measures as helping victims breathe, giving them intravenous fluids (fluids given through a needle inserted into a vein), giving them medications to treat conditions such as seizure and low blood pressure, flushing their stomachs with activated charcoal (if the ricin has been very recently ingested), or washing out their eyes with water if irritated

**Case Study:**

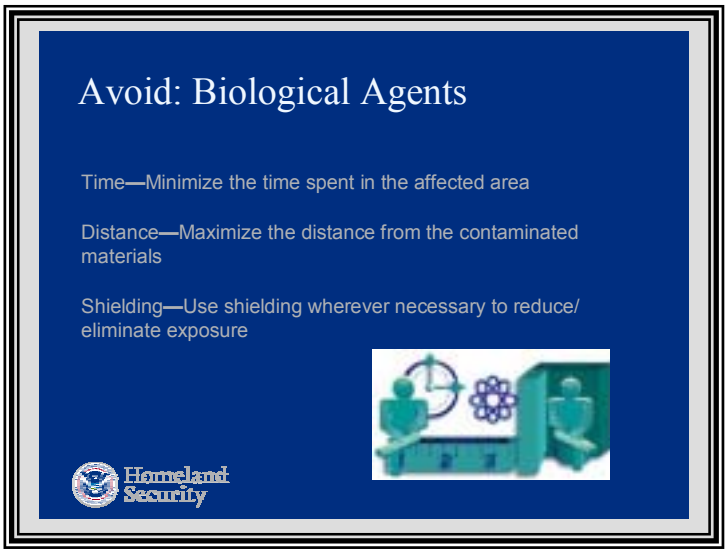
In November, 2003, the U.S. Secret Service intercepted a letter addressed to the White House containing a vial of the toxin ricin, but never revealed the incident publicly and delayed telling the FBI and other agencies. The letter contained complaints about trucking regulations and was nearly identical to one discovered one month earlier at a Greenville, S.C., mail-sorting facility that was accompanied by a metal vial that contained powdered ricin, sources said. In February 2004, Genetic testing by the Centers for Disease Control and Prevention provided further confirmation that the white powder found in an office of Senate Majority Leader Bill Frist was indeed ricin.

In February, 2004, three Senate office buildings were closed after ricin powder was found in an office of Senate Majority Leader Bill Frist. Dozens of Senate workers were monitored and health officials urged Senate staff to watch for swiftly developing fever, coughs or fluid in the lungs over a two to three day period. When inhaled in sufficient quantities or injected, ricin can be fatal, and there is no known vaccine or cure.

**Case Study:**

Although not as efficient as aerosol transmission, ingestion of contaminated food or water remains a concern. Two disease outbreaks in the United States have been caused by deliberate contamination of food. The first occurred in Oregon (1984), where members of the Rajneesh religious cult contaminated salad bars with *Salmonella*; over 700 people became ill. In 1997, a second outbreak occurred in a laboratory in Texas where an employee contaminated bakery goods with *Shigella* (shĭ-**gĕl**-ə) *dysenteriae* (dĭs-ĕn-tə-**rē**-ə); 12 people became ill.

## Avoid: Biological Agents



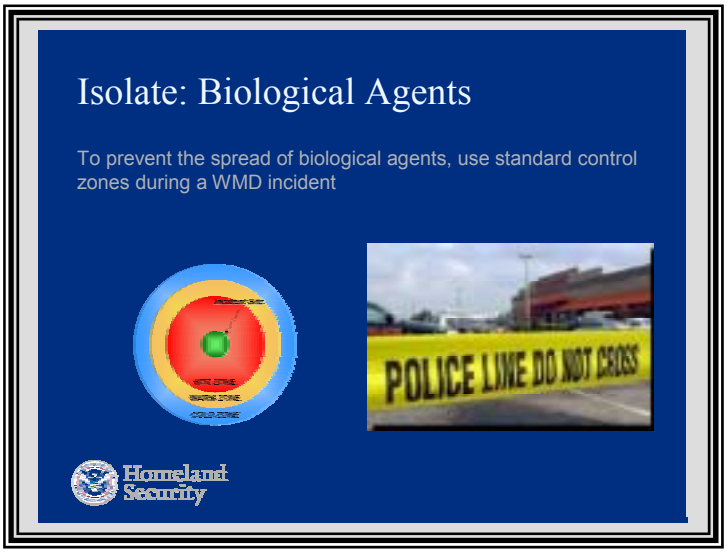

Individuals should use the principles of time, distance, and shielding to avoid biological agents.

- *Time—Minimize the time spent in the affected area*. The amount of time one is exposed to the hazard directly affects the risk level to life and the ability to effectively perform the assigned mission. Get out and stay out until the all clear signal is given

- *Distance—Maximize the distance from the contaminated materials*. Exposure is inversely proportional to distance; therefore, greater distance means less exposure. Do not increase the distance to the point where tasks are jeopardized. Stay at least 300 feet away on the upwind side when the agent is identified

- *Shielding—Use shielding wherever it is necessary to reduce/eliminate exposure*. By placing an appropriate shield between the contaminant source and the individual, some contamination and exposure may be completely eliminated or reduced to an acceptable level. The type and amount of shielding needed to achieve a safe working level varies with the type and quantity of agent or material used

## Isolate: Biological Agents




To prevent the spread of biological agents, individuals should use standard control zones during a WMD incident.

### Control Zones

Control Zones—The designation of areas at the hazardous materials incident based on safety and the degree of hazard. Many terms are used to describe the zones involved in a hazardous materials incident.

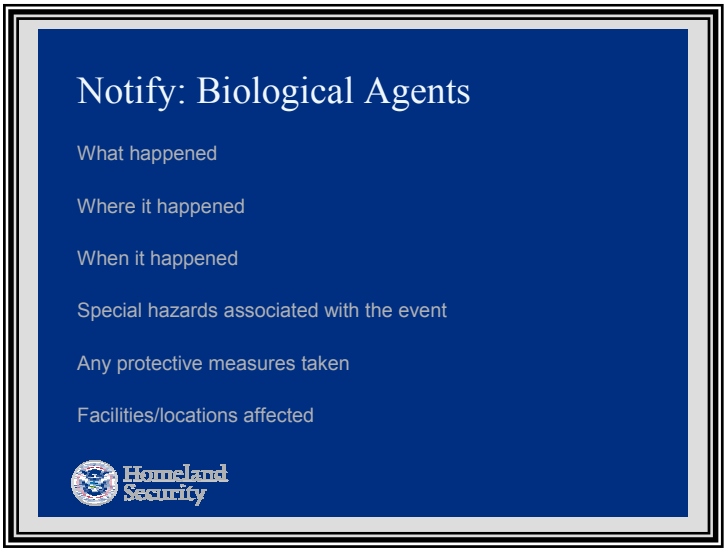
- *Hot Zone*—area immediately surrounding a hazardous materials incident, extending far enough to prevent adverse effects from hazardous materials releases to personnel outside the zone; also referred to as the exclusion or restricted zone

- *Warm Zone*—area where personnel, equipment decontamination, and hot zone support takes place. It includes control points for the access corridor, and thus assists in reducing the spread of contamination; also referred to as the decontamination, contamination reduction, or limited access corridor

- *Cold Zone*—includes command post and other support functions deemed necessary to control the incident

## Notify: Biological Agents

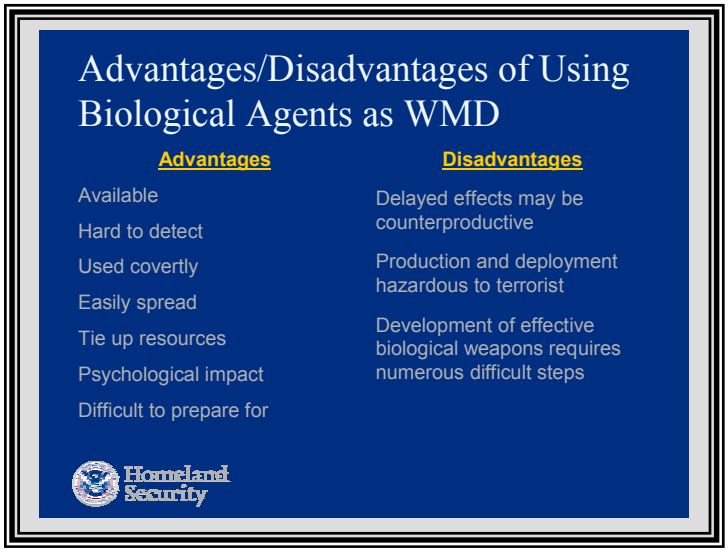
One must follow local protocols for notifying emergency services and emergency support personnel.




- What happened
- Where it happened
- When it happened
- Special hazards associated with the event
- Any protective measures taken
- Facilities and locations affected

## Advantages/Disadvantages of Using Biological Agents as WMD

### Advantages




- *Availability*—Biological pathogens can be obtained from nature, hospital labs, and university research facilities, among other places
- *Hard to detect*—Small quantities can have a tremendous effect
- *Used covertly*—Can be spread throughout large areas by natural convection, air or water currents. Biological agents as dust or vapors move with the air
- *Easily spread*—Ventilation systems in buildings or transportation facilities may actually become part of the dissemination system, carrying biological agents far from the initial source

- *Tie up resources*—In some cases, such as anthrax spores, a hazard can remain for many years; they sometimes require decontamination, tying up of resources, and increasing media attention and once disseminated, biological agents can remain in the air as vapor or aerosols, or they can settle on surfaces; this attribute requires that facilities be monitored and decontaminated before being returned to service; decontamination is a tedious, time-consuming, and resource-intensive process that requires personnel doing the work to be fully protected from the effects of the agent

- *Psychological impact*—Psychological impact will extend far beyond their actual effect; the mere thought of imminent exposure to a biological agent causes a terror reaction in many people

- *Difficult to prepare for*—It is difficult for civilian government agencies to prepare for biological terrorist incidents. Most civilian agencies now have some kind of HazMat response team available. While these teams and their equipment can form the core of an element that responds to a terrorist biological incident, they are likely to be challenged beyond their current capability in terms of knowledge, human resources, and equipment. The numbers of potential casualties, and the extent of the areas involved can quickly overwhelm the capabilities of any response organization. Medical personnel will be the initial first responders with large numbers of patients presenting similar symptoms. Good epidemiologic investigation of a disease outbreak will assist medical personnel in identification and management of the disease. In addition to emergency individuals, the entire healthcare community must be trained, equipped, and prepared to handle such incidents

**Case Study:**

A 1993 waterborne *Cryptosporidium* (krĭp-tō-spə-**rĭd**-ē-əm) outbreak in Milwaukee cites an example of how terrorists could use a biological agent, coupled with water currents to infect a large population. The outbreak was an inadvertent act that affected an estimated 400,000 people in South Milwaukee: 44,000 people sought medical attention; of those, 4,400 were hospitalized. The primary effect of the protozoan parasite was severe abdominal pain and diarrhea. The outbreak resulted from a sewage discharge into Lake Michigan from North Milwaukee, where water currents caused the flow to move south to the area where South Milwaukee drew its water for treatment for distribution and consumption. Poor water filtration processes failed to eliminate the *Cryptosporidium*. Monetary impact to the area was $31.7 million in medical costs and $64.6 million in total lost productivity.

**Case Study:**

One author reported a test in 1966 in which harmless biological organisms were introduced into the Seventh and Eighth Avenue subways in New York City. Within minutes, they were detected at the extremities of the subway system. Some weather/environmental conditions impact biological agents. Environmental impacts include extreme heat, wet, moisture, wind, etc.

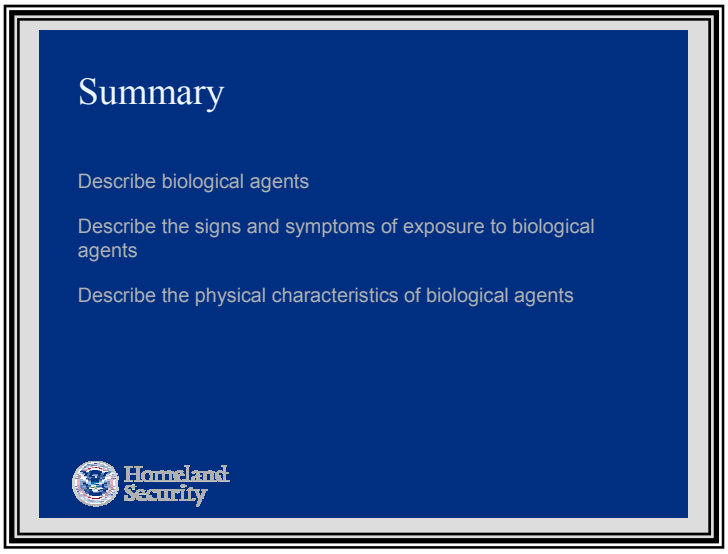
## Disadvantages

- *Delayed effects can detract from the intended impact*—Terrorist activities are generally intended to make a public political statement. Determining whether an outbreak of disease or illness is the result of natural causes or terrorism is a difficult task. This uncertainty as to the cause, and the time delay in identifying effects, can detract from the potency of the political statement or the credibility of the terrorist claim. This may be outweighed by the fear that is created. Even a hoax instills considerable fear

- *Production of biological agents and devices is hazardous to the terrorist*—Although commonly available HazMat equipment may provide protection to the terrorist, there is some risk of exposure and infection

- *Development of effective biological weapons requires numerous difficult steps*—One report listed 16 steps required to plan and execute a biological terrorist attack to kill millions; some steps would be difficult to complete. Problems cited ranged from lack of knowledge, difficulty in obtaining equipment and materials, safety, risk of detection, and difficulty in preservation and dissemination. The bad news—information, equipment, and skills required to accomplish these processes are readily available

## Module Summary




- Describe biological agents
- Describe the signs and symptoms of exposure to biological agents
- Describe the physical characteristics of biological agents